AFRL-SR-BL-TR-99-

0132

REPORT DOCUMENTATION PAGE

2. REPORT DATE 05 May 99

3. REPORT TYPE AND DATES COVERED FINAL 15 Feb 98 - 14 Feb 99

TITLE AND SUBTITLE

(DURIP)98/99) INTEGRATED INSTRUMENTATION SYSTEM FOR THE DEVELOPMENT OF IONIC POLARIZED POLYMER LIGHTEMITTING DIODES

3484/US 61103D

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SUPPLEMENTARY NOTES

DISTRIBUTION/AVAILABILITY STATEMENT

ABSTRACT (Maximum 200 words)

A major discovery of the polymer solution light-emitting device (SLED) was uncovered when studing the metal/polymer interfaces. An attempt to improve the device contact by adding solvents on top of polymer film and subsequently placing a metal contact above it. When biased, the device illuminated while the polymer film was still wet. That mechanism of this new type of device is still unclear, however its suspected that this unique device operates by an electro-generated chemiluminescence mechanism.

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Polymer Diodes

SECURITY CLASSIFICATION OF REPORT	SECURITY CLASSIFICATION OF THIS PAGE	SECURITY CLASSIFICATION OF ABSTRACT	LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

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May 5, 1999

Dr. Charles Lee
AFOSR/NL
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Dear Charles:

Enclosed please find our Fiscal Technical Report for our DURIP project. This DURIP has significantly enhanced my research capability and I would like to take this opportunity to thank you for your support. During my first two years of academic career, I am proud that we invented the hybrid inkjet printing as well as discovered the polymer solution LEDs. For research related these two inventions, the DURIP facility has made a significant impact.

You were the first program director that I visited when I joined UCLA two years ago, and you have witnessed the growth of our group. I sincerely hope that our outstanding research activity could be continuously supported by you. I can assure you that our group will become one of the best groups in the area of electronic polymers, and I hope AFOSR will play an important role in our growth.

With my best regards.

Sincerely,

Yang Yang

Final Technical Report

DURIP

Grant No. F49620-98-1-0311

Title: Integrated Instrumentation System for the Development of Ionic Polarized Polymer Light-Emitting Diodes

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Hardware (equipment) summary:

This DURIP grant has contributed strongly in initiating my research activity at UCLA. Being a first year assistant professor with limited initial funding for equipment, this DURIP grant helped me to equip my laboratory and allow me to initiate my research activity. Compared to the originally proposed equipment list, there have been several changes in the equipment purchased. We were able to purchase many extra pieces of equipment using this DURIP grant. One of the major reasons was due to a donation of a HP 4155A (Semiconductor Parameter Analyzer, costing $30,000) from HP Laboratory. [1] In the original equipment list, we budgeted a HP 4155A Semiconductor Parameter Analyzer. Fortunately, this donation allowed us to purchase other urgently needed equipment. Another major change was the purchasing of a nitrogen purge-box (~$11,000), instead of a nitrogen dry-box (~$33,000). Due to the improvement of our device fabrication technique, we were able to fabricate devices with excellent performance under less rigorous conditions. [2] Therefore, we decided to purchase a less expensive purge-box so that the money could be used to purchase equipment with broader applications.

Within the constrains of the budget, we purchased fourteen (14) pieces of major equipment, instead of the seven (7) pieces we originally proposed. The purchased equipment is listed in Table 1 below, the equipment marked * are the additional equipment that we purchased.

Table 1: Purchasing Equipment List

Vendor	Equipment	Price
1. Newport*	818-UV/CM Low-Power Detector	$ 564.30
	1815-C Optical Power Meter	$ 590.40
	1830-C Picowatt Digital Power Meter	$ 1,639.80
2. Janis Research Company*	VPF-475 Liquid Nitrogen Variable Temperature Dewar	$ 4,985.00
	8-Pin Resistivity Sample Holder	$ 185.00
	Upgrade to Refill Assembly	$ 370.00

	Wiring from Extra 8-Pin and BNC Feedthrus to Sample Mount	$ 250.00
	Neocera Model LTC-11 Temperature Controller	$ 2,610.00
3. Tucker Electronics*	TEKTDS430A Digital Storage Oscilloscope	$ 4,345.65
4. Photo Research Inc*	2900-0047-00Z PR-650 Spectracolorimeter (117VAC USA-PLUG)	$10,815.00
	8500-0001-45Z MS-2.5X Microspectar Lens, Calibrated	$ 1,700.00
	MS-2.5X Lens Replaces MS-75	-$ 1,340.00
5. Chemat Technology, Inc.*	KW-4A(110V) Spin Coater , 1/2 Diameter Chuck	$ 2,945.00
	Handle (Costume Made Box)	$ 30.00
6. Vacuum Atmosphere company	HE-43-2 Dri-Lab, work station	$ 7,720.00
	DLS-S Dri-Lab Support stand	$ 790.00
	HE-303 Fluorescent skylight	$ 200.00
	ACR-2 Antechamber Instrument Mounting Rack	---
	PC-1 Pedatrol. Automatic pressure Control	$ 1,215.00
	MPC Manual Purge Control	$ 1,200.00
	HE-503-1 Shelf Assembly	$ 205.00
	8B1532 L&R Buthyl Rubber Gloves	$ 155.00
	AC-4A Mini-Antechamber	$ 1,600.00
	Academic Discount	-$ 1,963.00
7. Pumps International, Inc.*	D25B(20CFM) Hydrocarbon Filled Vacuum Pumps (3EA)	$ 9,001.50
8. Brookkfield*	Programmable LVDV-II+CP Digital, Calculating Cone/Plate Viscometer	$ 3,385.00
9. Oriel Instruments*	14432 4 Inch Rod Holder	$ 34.00
	60056 Arc Lamp Source	$ 3,955.00
	71260 Quick Change Filter Holder	$ 227.00

	56531 Int. Filter	$ 433.00
	77800 Fiber Optic Assembly	$ 355.00
	77564 STD Grade FS Bundle	$ 723.00
	77646 FS Focusing Beam Probe	$ 152.00
	77612 RD Mount Probeholder	$ 37.00
	12350 Standard Rod 6.0 Inch	$ 20.00
10. Vacuum Atmospheres Company	HE-493/MO-5 Dri-train	$ 4,720.00
11. March*	CAM-F1 Contact Angle Measurements	$ 7,500.00
12. A.G.Heinze	Nicon E800 Optical Microscope	$41,864.20
13. Labsphere*	RSA-HP-8453 Reflectance Spectroscopy Accessory	$ 4,975.00
14. Hewlett Packard	8453A UV-Vis Spectrometer G1110AA System	$10,500.00
Total equipment cost		$128,693.85

Research and Education Summary:

Our proposed research focuses on investigating the metal/polymer interfaces of polymer LEDs. We have identified an effective method to fabricate ohmic contacts in polymer LEDs. An ohmic contact can be formed by first doping the polymer surface prior to the evaporation of the metal electrode. The formation of the ohmic contacts significantly enhances the device performance. One manuscript has been published on this subject. [2]

However, there is another major (or unexpected) achievement is the discovery of the polymer solution light-emitting device (SLED), which was discovered when we were studying the metal/polymer interfaces. One of our students, Shun-chi Chang, tried to improve the device contact by adding solvents on top of polymer film and subsequently placing a metal contact above it. When biased, the device illuminated while the polymer film was still wet. The mechanism of this new type of device is still unclear, however it suspected that this unique device operates by an electro-generated chemiluminescence mechanism.

There are many advantages associated with the SLED. The device has the potential of being a very efficient LED since it is not limited by the singlet recombination rules. Other significant advantages are the simplicity of device fabrication, large area processing capability, and pin-hole free nature. The SLED is also a self-encapsulated

device since it does not require a capping layer; the top ITO/glass plate serves as the capping layer. The edge sealing can be also be done by the regular fusion of glass and by taking care to include orifices in the edges for the introduction and removal of the polymer solution. Due to the use of dual ITO/glass substrates, the SLED is a highly transparent device. Finally, the low cost of fabrication and minimal wastage of polymer solution will be attractive features for future practical applications.

The equipment acquired via this DURIP program also helps the training of all our students. For example, Mr. Shun-chi Chang is an outstanding graduate student. Within one year, Chang has published as first author, three papers and filed one patent. [3,4,5,6] Mr. J. Bharathan, who recently obtained his master degree, also has two first authored paper published. [2,7] Another student, Guo, who recently joined our research group, has also demonstrated some outstanding results after only one month of participation in this project.

Under this program, students undergo a comprehensive training in science and engineering and we are proud to present their results to AFOSR through this technical report.

Reference:

1. Dr. Ron Moon, Manager, HP Photonic Laboratory.

2. Jayesh Bharathan and Yang Yang, "Metal polymer interface and the device performance of polymer light-emitting diodes", J. Appl. Phys., **84**, 3207,**1998**.

3. S.C. Chang et al., "Multicolor organic LEDs processed by inkjet printing", Advanced Materials, in press.

4. S.C. Chang and Y. Yang; "Polymer solution light-emitting devices", 74, 2081, Appl. Phys. Lett. (**1999**).

5. S.C. Chang, J. Bharathan, and Y. Yang; "Dual-color polymer LEDs processed by hybrid inkjet printing technology", **73**, 2561, Appl. Phys. Lett. (**1998**).

6. S.C. Chang and Y. Yang, Polymer solution light-emitting device, US Patent Pending.

7. Jayesh Bharathan and Yang Yang, "Polymer electroluminescent devices processed by inkjet printing: I. Polymer light-emitting logo. Appl. Phys. Lett. 21, 2660, (**1998**).